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Construction of the Evaluation Model for Ecological Carrying Capacity of Shallow Mountain Area in Beijing

Ying Li[a] Guo-hua Zhao Jing Zhou[b]

Key Laboratory of Urban Stormwater System and Water Environment (Beijing University of Civil Engineering and Architecture), Ministry of Education, Beijing, 100044, China

[a]liy@bucea.edu.cn , [b]247420322@qq.com

Abstract

Based on research about structures of ecological system and carrying capacity of shallow mountain area, evaluation index system of ecological carrying capacity of shallow mountain area had been formed, as well as the relative principle about how to choose index layer and sub-index layer in index system, and then built the evaluation index system for ecological carrying capacity and ecological stress, and constructed the evaluation model for ecological carrying capacity of shallow mountain area, which provide reference for sustainable development of shallow mountain area in Beijing.

Keywords: shallow mountain area; ecological carrying capacity; model construction; index system; evaluation model

1. Definition of ecological carrying capacity of shallow mountain area

Ecological carrying capacity of shallow mountain area is potential ability that ecological system of shallow mountain area maintains its own health steady development. From the world point of view, the input material from outside and the output waste of the ecological system of shallow mountain area is limited. When the speed of input or output fails to meet the survival and development speed of the ecological system of shallow mountain area, ecological environment problems (or threats) with features of current stage will emerge. As the threats accumulates to a certain degree and has not yet shown a declining trend or disappear, surpasses the carrying capacity of the system, it will lead degradation of ecological system and cannot be easily recovered.

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2. Construction of the evaluation model for ecological carrying capacity of shallow mountain area in Beijing

2.1Construction of the evaluation model for ecological carrying capacity of shallow mountain area

Evaluation of ecological carrying capacity in any area needs a set of complete index system as its theoretical basis of analysis, study and evaluation. This research divided evaluation index system of ecological carrying capacity of shallow mountain area into four layers: Layer 1 is general objective layer, namely, a whole ecological system; layer 2 is partial objective layer, namely, ecological carrying capacity and ecological stress; layer 3 is index layer, namely, index layer of ecological carrying capacity and ecological stress; layer 4 is sub-index layer, it can be divided by demand into sub-index layer 1, sub-index layer 2, and so on. Evaluation index system of ecological carrying capacity of shallow mountain area in Beijing is shown as Fig. 1.

It can be seen from Fig. 1, the general objective layer and partial objective layer are determined, so determining index layer and sub-index layer is the research center.

2.2Construction of index layer in evaluation index system of ecological system of shallow mountain area

Human activity has positive influence and negative influence on ecological system, that is, ecological carrying capacity and ecological stress, so index layer consist index layer of ecological carrying capacity and ecological stress.

1) Index layer of ecological carrying capacity

Human activity brings economic development and social progress to shallow mountain area, and promotes people using high technology and method to manage and maintain ecological balance. As one of internal motivations which develop shallow mountain area sustainably, human activity has potential internal motivation of ecological system, so on the basis of Gao Ji-xi evaluation model of ecological carrying capacity, add human activity potential to index layer of ecological carrying capacity. As shown in Fig. 2.

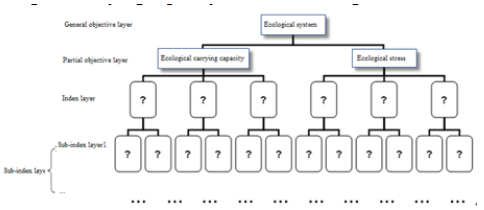

Figure 1 Evaluation index system of ecological carrying capacity of shallow mountain area in Beijing

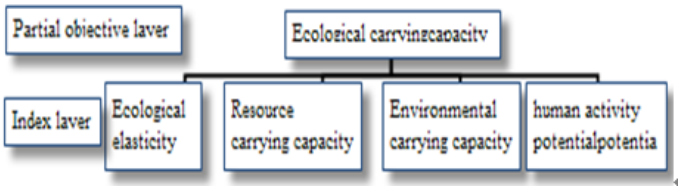

Figure 2 Index layer of ecological carrying capacity

1) Index layer of ecological stress

With the development of shallow mountain area in Beijing, human unreasonable exploitation and inefficient improvement of ecological system bring a series of problems, such as population increasing, resource shortage, environmental pollution, ecological damage, all which will exert considerable stress on the whole ecological system, so on the basis of Gao Ji-xi evaluation model of ecological carrying capacity, add the index of resource shortage, environmental pollution and ecological damage to index of ecological stress. As shown in Fig. 3.

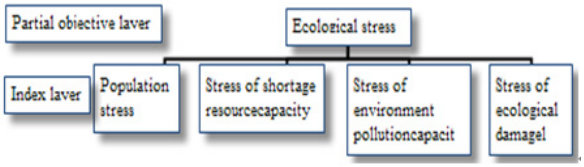

Figure 3 Index layer of ecological stress

3. Construction principle of sub-index layer in the evaluation index system of ecological system of shallow mountain area

As the bottom layer of the whole evaluation index system, sub-index layer can be divided by demand into sub-index layer 1, sub-index layer 2, and so on.

Instead of selecting all index listed by sub-index layer, depending on Beijing condition, the index selection of sub-index layer follows the principles as below.

3.1Representation principle

According to the natural, social and economic conditions and their development status, select the representation principles which can reflect the specific status and change of ecological environment in case district.

3.2Dynamics principle

There is a development of countries in shallow mountain area in Beijing at different degrees, so as to reflect the regulation of ecological system in the district timely, show the fluctuation of ecological system caused by the changes of each element in system obviously, only sub-index layer select dynamic index, it can reflect the evaluation of development, reveal the changeable feature of carrying capacity, put time into system dominantly or recessively, and then make the evaluation model dynamic.

3.3Transferability principle

Statistic data of shallow mountain area in Beijing has not detailed record like other cities, therefore, evaluation index data of countries in shallow mountain area depend on investigation at the field mostly. However, some monitoring data cannot be obtained by investigation, it can get data by transferring the index name and make it reflect problem clearly, which can avoid influence of miss data on the evaluation results.

3.4Not repetitive selection principle

In the evaluation index system of ecological system of shallow mountain area, if there exit common index in different influence factors, we can choose only one of them according to the calculation demand.

4. Construction of sub-index layer in the evaluation index system of ecological system of shallow mountain area

4.1Construction of sub-index layer of ecological carrying capacity

Sub-index layer of ecological carrying capacity of shallow mountain area consist four main index such as ecological elasticity, resource carrying capacity, environmental carrying capacity, human activity potential, aiming at the four index, determine sub-index now.

1) Construction of sub-index layer of ecological elasticity

In the Gao Ji-xi evaluation model, ecological elasticity consist five main index: climate, hydrology, soil, coverage of ground feature, ground feature. Ecological elasticity is not single index evaluation of climate or hydrology, so sub-index of the five index need not extensive detail, but wide-range representation is necessary. The research adopts frequency statistical method to statistic papers and reports about the five aspects[1,2,3,4,5], and then some index with higher frequency will be selected to evaluate the five aspects. Sub-index layer of ecological elasticity is shown as Fig. 4.

2) Construction of sub-index layer of resource carrying capacity

In the Gao Ji-xi evaluation model, resource carrying capacity consist four main indexes: water resource, land resource, tourism resource, mineral resource. The research adopts frequency statistical method to statistic papers and reports about the four aspects[6,7,8,9], and then determines some index with higher frequency, and determines the sub-index of resource carrying capacity according to the actual situation. Sub-index layer of resource carrying capacity is shown as Fig. 5.

3) Construction of sub-index layer of environmental carrying capacity

In the Gao Ji-xi evaluation model, environmental carrying capacity consist four main indexes: Water environment, Atmospheric environment, Soil environment, Acoustic environment. The research adopts frequency statistical method to statistic reports on the quality of the four aspects[10,11], and then determines some index with higher frequency, and determines the sub-index of resource carrying capacity according to the actual situation. Sub-index layer of environmental carrying capacity is shown as Fig. 6.

4) Construction of sub-index layer of human activity potential

Human activity potential consist economic development index and social development index. The research adopts frequency statistical method to statistic reports about the two aspects[12,13], and then determines some index with higher frequency, and determines the sub-index of human activity potential according to the actual situation. Sub-index layer of human activity potential is shown as Fig. 7.

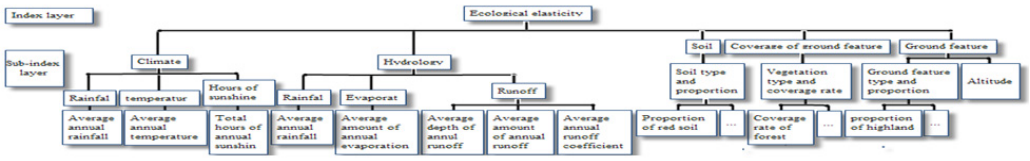

Figure 4 Sub-index layer of ecological elasticity

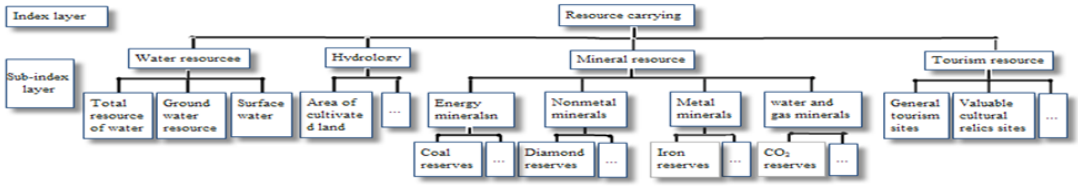

Figure 5 Sub-index layer of resource carrying capacity

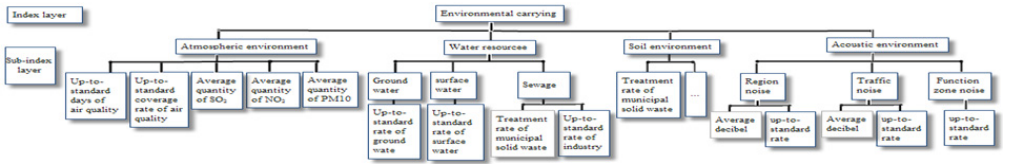

Figure 6 Sub-index layer of environmental carrying capacity

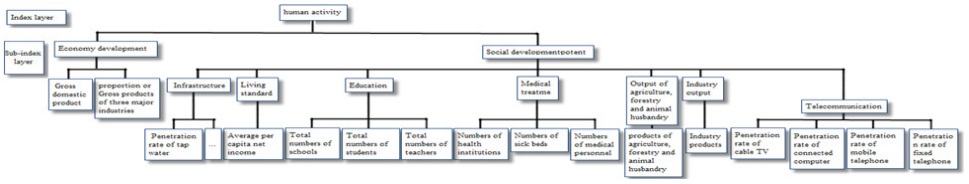

Figure 7 Sub-index layer of human activity potential

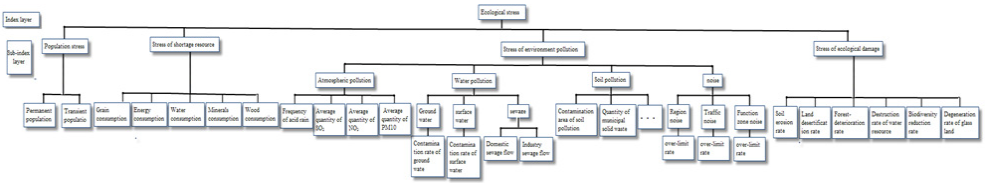

Figure 8 Sub-index layer of ecological stress

5) Construction of sub-index layer of ecological stress

Ecological stress consist four main index: population stress, stress of shortage resource, stress of environment pollution, stress of ecological damage. The research adopts frequency statistical method to statistic reports and papers about the four aspects[14,15,16,17,18], and then determines some index with higher frequency, and determines the sub-index of ecological stress according to the actual situation. Sub-index layer of ecological stress is shown as Fig. 8.

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